

# IV

## REFLECTIONS ON THE FREEDOM OF SCIENCE

### I

ALL of us have had intimate experience of learning and failing to learn, and so we may think of knowledge as a private possession or a personal accomplishment. Indeed, it is that; but it also has a larger context. Knowledge is a cultural phenomenon. Science, the deliberate pursuit of knowledge, is an institution characteristic of Western Civilization. To say it is an institution is to say that it consists in an organization of individual activities about urgently felt needs. In so far as it depends on perception and springs from instinctive inquisitiveness and the effort toward self-preservation, knowledge is continuous in an evolutionary sense with animal irritability or feeling. But science could not begin until the instinctive had gathered to itself the meanings and controls comprised under the broad notion of civilization. In fact, it seems to have required the special complex of circumstances which produced the ancient Greek civilization, since in no other, apart from Greek example and influence, have cognitive activities been able to disentangle themselves from the other uses of the mind and embark upon a comparatively independent career of their own.

The growth of this specialty doubtless exhibits similarities to the growth of all the other specialties which mark the existence of civilization. Specialization is one of the decisive tricks by which human groups have contrived to increase

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their total efficiency. The Jack-of-all-trades proverbially excels at none; he lacks concentration. Yet if his energies are not to be dispersed in a round of daily tasks, his necessary wants must be cared for by others. Only in this fashion is it possible for him to devote himself with singleness of purpose to the cultivation of some particular skill. An exchange of services is thus required as a necessary condition of a division of function. The development of specialties cannot, therefore, be the product of merely individual initiative, however important that also is, for it marks a growing dependence of men upon each other and creates an intensified need for organizing diverse functions into a common life. This is a further reason why specialization has been an overwhelmingly successful trick: in addition to increasing the sum of individual abilities, it encourages new achievements in the difficult art of coöperation.

If some particular interest, say curiosity, is to separate itself from the common matrix of life, so that it acquires an independent status, generating its own institutions and inner discipline, then it must perform services which the community (or an effective segment of it) considers commensurate with its implicit claim upon the general resources, spiritual as well as material. And so the conception of their true welfare, which members of a community have, determines what they particularly concentrate upon. The degree of development and relative authority of their major institutions outline their dominant valuations. If an institution ceases to satisfy a persistent interest, or if the interest which it promotes vanishes, or if in time the orientation of the whole of life undergoes a transformation, then the institution will become decadent or be crowded out by more active concerns. In the long run, each specialty must maintain itself by its contribution to the organization of all specialties in the unity of a common life.

Though these remarks seem obvious, the truth to which they allude is not always easy to recall. To the specialist the particular object of his interest almost inevitably appears bigger than life. He suffers a strong temptation to make everything a branch of his own specialty, as G. Lowes Dickinson once put it. His very concentration makes him jealous of interference; quite properly, he wants to get ahead with his work. He tends to think of his work as a thing apart, with an unqualified right to develop according to the inner necessities of its nature. When this belief becomes articulate, then one hears the familiar doctrines: art for art's sake, knowledge for its own sake, virtue is its own reward, business is business.

Unqualified freedom amounts to the enjoyment of rights without corresponding duties; it implies a claim upon the protection of law without itself being under legal control. Sometimes we think ourselves free in this unrestricted way, if we are aware of being left alone but are not equally aware of the positive tolerance of those who leave us alone. It takes a threat of interference to make us aware of it. Whereas formerly advanced physical research has been tolerated with the mixed astonishment and contempt which most people reserve for harmless and disinterested learning, it has now turned into a political and military issue. Over all there hovers a sense of urgency, which shows how well we have learned that, instruments of force being as recondite and intricate as they now are, the frail balance of international power may at any moment be upset by a discovery in the laboratory. With this new *general* recognition of the value which a vigorous scientific establishment has for the nation, science is brought within the orbit of national purpose. There is, of course, nothing new in requiring the man of science to do his duty as a citizen and place his special abilities, if need be, at the service of his country in time of war. But never before have they

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been required in peace time, at the level of basic research, and on so extensive a scale. Never before have abstruse developments at the advancing front of knowledge possessed such immediate and far-reaching practical import. The customary balance of controls in modern science may be at the point of being upset, with the interest in utility winning the upper hand at last over the love of truth. This does not mean that the individual chemist or physicist or biologist has lost interest in his subject. It does mean that supreme control of research may pass into the hands of men who are enormously more impressed by the power, ultimately the military power, yielded by science than by the truth which it reveals. If this should happen, science will become a tool of powerful interests, just as medieval philosophy, including natural philosophy, was the handmaiden of religious conformity.

Perhaps this analogy is not as fanciful as it may appear at first sight. It would be close indeed if, as Reinhold Niebuhr holds, certain economic and political beliefs have assumed the force of passionately held religious dogmas, a kind of idolatry of nation or class. Whether or not, in this suggestion, excitability outruns sober judgment, the period of *laissez faire* in scientific research, no less than in economic and political affairs, appears to be ending, and with it the illusion of unconditional independence. We must think more concretely, therefore, about the nature of science.

Where, it may be asked, is the philosophical problem here? Practical and political problems there may be in great plenty; but political crises cannot alter the logical character of knowledge, respecting which alone scientific freedom has meaning. This is the freedom to affirm as true only propositions which satisfy the most exacting demands of critical intelligence. Even logicians and epistemologists, as disputatious as they are, are compelled to agree regarding these demands,

for none will deny that factual knowledge must conform to the joint criteria of precise fidelity to deliberate observation and systematic theoretical consistency. Other considerations are irrelevant. Neither piety nor righteousness, nor expediency, nor good taste and good manners, neither private predilection nor public approval, have evidential force. In virtue of the inner necessity of conforming to its own criteria, science must possess autonomy; its claim to freedom of self-determination is self-justifying.

There is no reason to gainsay any of this. It should be recognized, however, that the notion of pure science is an abstraction—a selective emphasis, valuable for certain purposes, of a real and vital aspect of concrete fact. Still, it is an abstraction, and it omits no less significant aspects which are crucial in the present context. There is an analogy in morals. Though autonomy of the will may be the necessary condition, as Kant held, for moral freedom, yet for *men* to be free requires a good deal more than this in the way of legal order in the political community. Similarly, the autonomy of the intellect is undoubtedly a necessary condition of any knowledge whatsoever, but this alone cannot guarantee freedom for the scientist any more than it can confer on him control of the whole social institution which is modern science. The position of science in a culture, the kind of “freedom” it enjoys—this is determined by the ends towards which the people as a whole direct their activities, by the prevailing opinion regarding the role of science in life, by the impersonal pressure of events, and only in part by its own logical purposes and native tendency.

## II

Some light may be thrown on these very general remarks by a study of the contrast between the two great periods of

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scientific activity. To speak of *the* contrast, as if it were a rather simple and obvious thing, is, of course, misleading. But sufficient preliminary accuracy may be achieved in terms of a characteristic opposition between Platonism and certain phases of modern instrumentalism. For Plato, knowledge was a 'noble and commanding thing,' the only true qualification for political authority, the condition on which in the last resort the welfare of all depends. For instrumentalism, on the other hand, which has been elaborated during the last half century in the name of science and democracy, knowledge is the instrument, though not quite the "tool," of practice.

Plato was working within a mature intellectual tradition when he discussed the nature and cultural significance of science. He was also under the influence of Socrates's ethical ideas. The combination of these factors determined his evaluation of the role of exact knowledge in civilization. From his great master, whose discourses he had listened to during impressionable years, Plato gained the ineradicable conviction that "the unexamined life is not worth living"; that it is impossible to live and act well unless spiritual ignorance has been overcome by rational discipline culminating in a knowledge of the good. Excellence in the management of human affairs of any kind, whether public or private, requires wisdom, a reasoned appreciation of well-being. But Plato also realized that such wisdom, if it can be directly cultivated at all, can be so only after a lengthy and arduous preliminary education of moral character, taste, and intellect. That is to say, it is possible only for members of a high civilization, whose natural love of fair things and fair deeds has grown deep and true under the solicitation of their material and social environment. The final achievement, however, involves a cultivated intellect, a mind trained to see the general principle in the particular case, and relentless in exposing

the pretence of merely casual emotion and merely plausible opinion. Consequently, when he outlined the kind of education which might help produce men of wisdom, Plato proposed as a preparation for the final effort at critical evaluation first a thorough inculcation of good habits and good taste and then advanced instruction in all the exact sciences, mathematical and physical. The chief value of the study of what we should call science was thus found in the cultivation of objective and logical habits of mind, which are indispensable to the growth of that wisdom which is the salvation of families and states.

It may seem odd that a view which makes virtue depend on the exercise of reason should be assailed on the ground that it separates theory and practice. But the instrumentalist does attack it on this ground, because he conceives practice to consist primarily in the effort to control the natural processes which provide the framework for individual and social life. Theory has the function of rendering this control more reliable. It is thus inseparable from the techniques of manipulating and changing the course of nature. Greek philosophy, according to this view, did not stoop to this. "It is not to be inferred," Dewey explained in *The Quest for Certainty*, "that Greek philosophy separated activity from knowing. It connected them. But it distinguished activity from action—that is, from making and doing." (P. 17) A moment later he is generalizing about "the chief philosophical tradition." "According to it," he says, "the realms of knowledge and of practical action have no inherent connection with each other." (P. 19) Activity, supremely exemplified in critical reflection and contemplation of the highest and most divine things, is thus conceived to be akin to aesthetic enjoyment rather than to practice; but action—making and doing—takes our ideals down into the bruising turbulence of ex-

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istence where false steps are quickly repaid with hard knocks. An image of the good does not answer to our needs, nor an understanding of the general character of nature and our place in it. We must above all know exactly how to achieve what we aim at; if we aim at the wrong thing, experience will soon enlighten us. Knowledge, therefore, has value primarily as the power to get our way by controlling natural interactions of things, of men, and of social groups. The contemplative concentration of the mind in a final appreciation of the highest truth, which Aristotle no less than Plato hailed as reason's supreme achievement, may be agreeable, the crown of leisure, but it is not knowledge, except as it has been put to the test of practice. Apart from making and doing, theory is a beguiling amusement, diverting us from the urgencies of action.

Whatever the merits of this interpretation, it fails to bring out the actual accomplishment of the Greeks. For they performed the infinitely difficult and indispensable work of genius. They took the first unimaginable step toward that superb specialization of knowledge which forms the background and condition of the instrumentalist criticism. Early in the sixth century B.C., according to the learned tradition, Thales, a citizen of the Ionian city of Miletus, began the pursuit of knowledge for the sake of enlightenment. In effect, he discovered that cognition was capable of independent development, extricated from its habitual entanglement in mythological symbolism and ritual practice. He discovered the art of speculation, of looking on disinterestedly, of theorizing abstractly. The concept of nature emerged as the objective counterpart of this independence of cognitive function; the love of truth appeared as a new spiritual motive.

The next essential step was to distinguish this activity from everything which might distract it, and find out what



theory could do by the simple device of trying it out—not that this sophisticated program could be consciously followed in an age of speculative innocence. Rather, it was as if an intoxicating promise had been felt in the new art of theorizing, which was practiced with perhaps more enthusiasm than discernment. Everything was fitted into a theory, without much fuss, in the beginning, about the kind of fit. In this way, the Greek intellectual quickly learned to recognize and contrast opposed theories, to array evidence, to support opinions with consecutive arguments, and to detect inconsistencies. He learned—and this was the essence of his achievement—to disengage his perceptions and beliefs from their natural, primitive immersion in action, and to raise them to the symbolic level, where they could be discussed in their general significance rather than acted upon in the obdurate particularity of their existence. He learned, that is to say, to analyse, to generalize, and then to criticise abstractions; he learned the distinction between reasons and inducements, and that between invalid and valid argument, although the *theory* of argument had to await Aristotle. The result, within little more than two centuries, was the beginnings of scientific arithmetic, geometry, harmonics, astronomy, the empirical medicine of the Hippocratic tradition, a somewhat halting physics and biology, and objective studies of cultural phenomena such as language, custom, law, history, and perennially illuminating interpretations of moral and political principles.

All this was made possible by turning away from “making and doing.” Geometry and astronomy, the two sciences in which the Greeks excelled, both grew out of lore borrowed from foreign cultures for which the Greeks had practical rather than theoretical interest. Geometry, as a technique of land measurement, had plain advantages in agricultural Egypt, with its frequent floods and efficient system of taxa-

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tion. The Greeks borrowed everything they could, and, generalizing, seeking reasons, systematizing, made a science of it. Similarly, they created scientific astronomy, instead of resting content with the lore which older civilizations had found sufficient for agricultural, ceremonial, and astrological purposes. Thales is said to have predicted an eclipse, doubtless relying on borrowed techniques. About two centuries later, Eudoxus, Plato's younger contemporary, was offering a geometrical explanation of the apparent motions of the heavenly bodies in terms of supposed true motions of concentric spheres. This is exactly the sort of development which Plato sponsored in his famous advice to astronomers, that they deal with problems and leave the heavens alone. (*Republic* VII, 530B) What was needed was not more data but better theory. The rational study of stellar motions was hence proclaimed, like the rest of mathematics, an essential ingredient of higher education.

Plato was fully aware of the practical utility of geometry, arithmetic, and astronomy in agriculture, commerce, and war; but he correctly appraised their then possible applications as scientifically trivial, however indispensable to efficiency. Besides, he had learned from Socrates that the chief problem is not how to *make* things but how to *be* men. To him the true use of science could only be the higher one, which obtained institutional embodiment in the Academy, to foster intellectual maturity and cultivate that superb disinterestedness which is a propaedeutic to moral generosity and political wisdom.

In its first appearance the scientific spirit tried to fly. It had to rise above the ordinary practical interests to explore its own possibilities. As a result it contributed to an invaluable critical clarification of ethical and religious ideas, one of the supreme achievements of all time. Clarification of knowledge

was regarded as purification of the spirit, making possible the direction of life by a true vision of the good. But the Greeks were unable to derive detailed techniques for practical achievement. They did not develop experimental methods beyond a rudimentary point, partly because they lacked a flexible algebra, partly because, though they wished to save the phenomena, they underestimated the difficulty of determining which phenomena were worth saving, and also partly because they most desired the enlightenment of an intelligible world view. The minor details were less important than the major features of the cosmos. A purpose enlightened by true vision could be trusted to find detailed expression in practice.

## III

The circumstances of the second incarnation of the scientific spirit were profoundly different. The reflective, rational clarification of ethical and religious ideas had been carried far enough for the main principles to be taken as established. There remained the practical task of translating Christian charity into concrete service in *this* world. The study of nature, fascinating in itself, was also valued for its promise of aid in this great task.

To bend nature to our purpose so as to improve the natural condition of mankind, we must, as Bacon said, obey her; we must learn her ways and take advantage of them. Observation acquired a new importance, particularly the contrived and measured observation of experiment. Attention was turned to the detailed processes of isolated systems, and to the mathematical determination of the simple case, as a necessary condition of solving larger problems. A. D. Ritchie has commented on the arduousness of this procedure. "After all," he remarks, "men have no natural instinct for experi-

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ments of the kind that are needed in science. They are difficult, tedious and often disappointing operations. A very strong motive is needed to make men do them." (*Civilization, Science and Religion*, p. 45) The early moderns not only had a number of strong motives but enjoyed, as compared with the Greeks, a number of marked advantages. They felt the same curiosity and wonder and the same zest for life; in addition, they were turning away from a stereotyped set of ideas to an exciting exploration of new possibilities, fraught with untold promise of novel benefits. They were equipped for the task by the best of Greek science, by a superior algebra, by a taste for novelty sharpened by geographical exploration, and by a new respect for the practical techniques and mechanical knowledge, painfully learned by countless generations of inarticulate craftsmen and nameless inventors. Wonder and the passion for constructive betterment of the human lot had the equipment with which to begin. How pointless was rational speculation when there was work to be done, finding out what the world is in detail and remaking it nearer to the heart's desire. Knowledge, Bacon proclaimed, is power.

Bacon's genius had correctly assessed the relation between knowledge of fact and productive arts. From the first there has been an exchange of services. Mechanical invention preceded mechanical science. Clocks, for example, were fairly common in church steeples by the middle of the fourteenth century; large scale applications of many basic types of machines are known to have been common in mines before the middle of the sixteenth century. Pumps were in use long before studies of the weight of air were undertaken, or the action of the heart understood. The investigation of terrestrial magnetism followed the employment of the magnetic compass in navigation. Galileo himself tried to find a theo-

retical method of determining the strength of beams, a project of obvious interest to architect and engineer. On the other hand, practice obtained new guidance from theory. Galileo's purely scientific investigation of falling bodies furnished the solution of a fundamental ballistical problem, which the invention of cannon had rendered important. Sanctorius put the isochronism of the pendulum to clinical use in the pulsimeter. Astronomy and navigation both benefited by the application of the same principle to clockmaking. Incidentally, no other single practical difficulty supplied as much impetus and direction to research as the problem of ocean navigation. What has been called "the world's first laboratory of applied science" (Ritchie, *op. cit.*, p. 110) was established, more than fifty years before the voyage of Columbus, by Prince Henry the Navigator to improve seamanship and navigation. Greenwich Observatory was established by Charles II "for the use of his seamen." (A. Wolf, *A History of Science, Technology and Philosophy in the Sixteenth and Seventeenth Centuries*, p. 178. To Wolf is due my appreciation of technology's early independence of science [cf. pp. 450-452] as well as a number of the facts mentioned above.)

Scientists owed to practical men more than the intellectual stimulation of problems and the satisfaction of helping with the work of the world. They owed also the indispensable practical means of experiment, the fine instruments which skilled craftsmanship makes possible: telescopes, micrometers, air pumps, and a thousand others. And they have repaid their debt—how generously our industrial society attests.

From this active alliance of science and skill we have received the joyous gift of liberation from superstition due to ignorance of causes. This, however, was not an isolated phenomenon but part of a larger movement of liberation, which penetrated every corner of life. Religious superstition was

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also subjected to a religious criticism by the Reformation and Protestantism. Authoritative ideas were submitted to the test of personal experience in religious life. Science, it is true, had to win its own bitter struggle with both Protestant and Catholic bigotry. It deserved to win, being armed with infinitely better methods of investigating facts and possibly with greater purity of motive than its antagonists. It does not follow, however, that it did win simply on merit, as if the whole issue lay between benighted religious conservatism and iconoclastic scientific progressiveness. It implies no derogation of the merits of science in the conflict or of its contribution to the victory to suggest that it did not fight alone. Galileo's humiliation, though the most famous, was neither the first nor the last penalty exacted of men for their science. Nevertheless, more than a dispute about matters of fact was at stake—nothing less than an order of ideas and purposes, a way of life, a particular constellation of social and political powers and institutions. The steps by which science won and consolidated its freedom accompanied the gradual advance of a new evaluation of life. The theoretical turning points in the cosmological struggle were the Copernican and Darwinian hypotheses. But it may be doubted that successful resistance to the power of entrenched institutions would have been possible without the coöperation of what we are likely to consider all the major architectural forces in the making of the modern world. Scientific freedom was achieved along with freedom of conscience, freedom of discussion and speech, political liberty, and perhaps even free enterprise in business.

The respective contributions of the allies in the struggle have been variously assessed. A.D. Lindsay, for example, has suggested that "what Western civilization did in both religion and science in the sixteenth and seventeenth centuries was a supreme act of Christian faith. . . . The beginning of the

modern adventure in both science and religion was the revival of the essentially Christian conception of the infinity of God and the consequent realization that God had given man an infinite task in understanding and doing His will and knowing His world." (*Religion, Science and Society in the Modern World*, p. 10) He goes on to refer democratic practices too to a source in Protestantism: "The democratic state is at best only an analogy of the really democratic religious congregation." (P. 19) His point is that speculative diversity and free discussion were fruitful when disciplined, not by fixed creeds, maintained by personal or institutional authority, but by a unity of fellowship. On the other hand, it is more commonly held today that the characteristic institutions and so-called ideologies of the present are traceable to economic factors and mechanical invention and the consequent new alignment of social powers. And a third view is that of the instrumentalists, who see in experimental science itself the truly constructive historical force, which tends to maintain free social and political institutions, while encouraging us to work for the enjoyment in this life of the goods formerly postponed to heaven.

There are, no doubt, elements of truth in each of these views. Religious, economic, and scientific activities may all give expression to our deep ambition to develop our capacities to the full. Free institutions have correspondingly developed: Protestant sects multiplied; church was separated from state; economic privilege was largely divorced from the old hereditary aristocracy; political power passed to the middle classes in democratic institutions; and ecclesiastical control over education was weakened or destroyed. Religious, economic, political, and academic liberalisms reinforced one another.

By this century science seemed to have won untrammelled liberty, except for minor skirmishes with anti-evolutionary

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sentiment in backward areas. Did not scientists form a great international community enjoying utmost freedom of communication? Learned publications passed without hindrance through the mails everywhere. Scientists were themselves welcome in every land. What matters a man's nationality if he is helping in the infinite task of disclosing truth? Also in the universities the sciences had gained prestige. Whereas in the seventeenth century they had sought the protection of special academies and societies under royal or princely patronage, they now enjoyed recognition, not only as specialties, but as essential elements of a *liberal* education. The Platonic insight that something of the spirit of pure science must inform any cultivated mind was thus realized in institutional form once more.

The right, however, which the sciences validly claim, and the universities properly protect, as academic freedom, to seek truth and expound it without fear of retaliation, confers no special license to create instruments of power. Abstract knowledge, to be sure, is not itself power. But it is an increasingly indispensable means to practical invention on behalf of non-scientific purposes; and the art of converting theoretical knowledge into efficacious machinery is far advanced. The old alliance between theory and practice has now begun to plague us. Doubts about practical purposes have rendered even theory an object of anxious scrutiny. Pure research no longer enjoys immunity from control by centralized authority, any more than scientists and scientific information can freely travel over the world. Science won its freedom on the theoretical plane of cosmology; its ally in that struggle, technology, has created a new threat, and even basic discoveries must be watched by those in power. This may be deplorable. But what else can conscientious men do under their burden of responsibility?



This is a further stage of the mutual adjustment of specialties, which was remarked upon in the opening paragraphs. Theoretical science faces new, or at least newly recognized, responsibilities. If this seems surprising, perhaps it is because we have rather naïvely assumed that if we attend to the technical details, the major ends will take care of themselves, the opposite of the Greek assumption that an enlightened mind will find sufficient expression in the details of practice. In the past, the naïveté has perhaps had sufficient excuse in the fact that the chief beneficiaries of scientific advance, medicine and industry, have objects to which we gave our unhesitating approval. One has reduced the natural evils of pain, disease, and premature death. The other has reduced poverty and increased the leisure which is necessary for liberal pursuits. The simple trust that these things will take care of themselves is no longer possible. The recent demonstration that an instrument, scientific or technological, may serve quite different purposes has been too thorough to be misunderstood.

Pure science is confronted now with a threat from this quarter. It will need more extensive armament than its methods of demonstrating matters of fact. It will require moral greatness and courage in resisting the temptation to pursue the expedient, if it is to continue as an autonomous discipline of the spirit, one of the glories of reason, rather than an adjunct to the arts of war and politics (including industry). Did not Archimedes, absorbed in the study of his problem, tell the Roman soldier not to disturb his circles in the sand? The soldier killed him. He cared neither for the problem nor the man. And science died with him for nearly two thousand years.

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